

Claims

- 1 1. A metallic liquid jet cutting system for modifying a workpiece comprising:
2 a dispenser for dispensing a jet stream of an electrically conductive fluid; and
3 a power source electrically coupled to the jet stream.
- 1 2. The system of claim 1 wherein the dispenser comprises a jetting head.
- 1 3. The system of claim 2 wherein the jetting head comprises a crucible
- 1 4. The system of claim 3 wherein the crucible comprises a top, a sidewall, and a bottom,
2 wherein the top comprises an inlet and the bottom comprises an outlet.
- 1 5. The system of claim 3 wherein the crucible comprises one of boron nitride-zirconia-silicon
2 carbide, Ytria-Stabilized-Zirconia, Magnesia-Stabilized-Zirconia, Calcia-Stabilized-Zirconia
3 boron nitride, Cubic Zirconia, alumina, silica, silica composites and zirconium diboride.
- 1 6. The system of claim 3 further comprising a heater coupled to the crucible
- 1 7. The system of claim 6 further comprising a second power supply electrically coupled to the
2 heater.
- 1 8. The system of claim 2 wherein the jetting head comprises an inlet for receiving a feed stock
2 of the conductive material.
- 1 9. The system of claim 1 wherein the conductive material comprises mild steel, aluminum,
2 aluminum alloy, tin, stainless steel, iron, cast iron, tool steel, copper, zinc, gold, silver, or
3 platinum.
- 1 10. The system of claim 2 wherein the jetting head comprises a pressure containment vessel.
- 1 11. The system of claim 2 wherein the jetting head comprises an electrode disposed inside the
2 crucible for establishing an electrical connection with the jet stream.
- 1 12. The system of claim 11 wherein said electrical connection comprises a feedstock of

2 conductive material.

1 13. The system of claim 2 wherein the jetting head comprises an exit orifice.

1 14. The system of claim 2 wherein the jetting head further comprises a nozzle.

1 15. The system of claim 14 wherein the nozzle comprises a disk having a through orifice.

1 16. The system of claim 15 wherein the disk comprises a material selected from one of Yttria-
2 Stablized-Zirconia, Magnesia-Stabilized-Zirconia, Calcia-Stabilized-Zirconia, boron nitride-
3 zirconia-silicon carbide, boron nitride, Cubic Zirconia, Alumina, Silica, Silica Composites,
4 Zirconium Diboride.

1 17. The system of claim 15 wherein the through orifice comprises a circular cross section.

1 18. The system of claim 6 wherein the heater comprises one of an AC resistance heater, a DC
2 resistance heater, an induction heater, or a combustion burner-heater arrangement.

1 19. The system of claim 3 wherein the crucible comprises a refractory material.

1 20. The system of claim 3 wherein the crucible comprises ceramic material.

1 21. The system of claim 3 wherein the crucible comprises a material selected from one of
2 alumina, zirconia, boron nitride, and graphite.

1 22. A metallic liquid jet cutting system comprising:

2 a jetting head including an inlet for receiving a feed stock of a conductive material and an

3 exit orifice for dispensing a jet stream of a conductive fluid;

4 a heater coupled to the jetting head; and

5 a power source electrically coupled to the jet stream for providing a current to the jet stream

6 to increase a temperature of the jet stream.

1 23. A process for modifying a workpiece comprising:

- 2 (a) providing a jet stream comprising a conductive fluid;
- 3 (b) coupling an electrical current into the jet stream; and
- 4 (c) directing the jet stream to the workpiece for modifying the workpiece.
- 1 24. The process of claim 23 wherein step (b) comprises heating the jet stream by passing the
- 2 electrical current through the jet stream.
- 1 25. The process of claim 23 wherein step (a) comprises (a1) providing a feed stock of the
- 2 conductive fluid, (a2) heating the feed stock to form the conductive fluid; and (a3) passing
- 3 the conductive fluid through an exit orifice, thereby forming the jet stream.
- 1 26. The process of claim 23 wherein step (a) comprises providing one of a continuous jet stream,
- 2 a pulsed jet stream, a steady jet stream, or a unsteady jet stream.
- 1 27. The process of claim 23 wherein the feed stock comprises a wire, bar, or powder.
- 1 28. The process of claim 23 further comprising the step of (d) lowering a melting point of the
- 2 workpiece.
- 1 29. The process of claim 28 wherein step (d) comprises lowering the melting point by forming an
- 2 alloy of the feed stock.
- 1 30. The process of claim 25 wherein the feed stock comprises one of iron, aluminum, tin, nickel,
- 2 titanium, gold, platinum, silver, magnesium, and copper.
- 1 31. The process of claim 23 wherein the conductive fluid comprises a low melting point of less
- 2 than 1000° K and a high boiling point higher than 2500 ° K.
- 1 32. The process of claim 25 wherein the feed stock comprises a plurality of non-melting
- 2 particles.
- 1 33. The process of claim 32 wherein the non-melting particles are abrasive.
- 1 34. The process of claim 23 wherein step (c) comprises one of cutting, marking, piercing or

2 welding the workpiece.

1 35. The process of claim 23 wherein step (b) comprises applying a current to the jet stream
2 through an electrode coupled to the conductive fluid and a current collector disposed near the
3 workpiece.

1 36. The process of claim 23 wherein step (a) further comprises providing a levitation force to the
2 conductive fluid to plug the exit orifice.

1 37. The process of claim 25 wherein step (a1) comprises providing the feed stock in a jetting
2 head.

1 38. The process of claim 25 wherein step (a3) comprises passing the conductive fluid through a
2 nozzle.

1 39. The process of claim 23 further comprising providing a shielding gas to the jet stream

1 40. The process of claim 25 wherein step (a3) comprises pressurizing the jetting head while
2 passing the conductive fluid through the exit orifice.

1 41. The process of claim 25 wherein step (a3) comprises pressuring the jetting head by supplying
2 an inert gas.

1 42. The process of claim 23 wherein step (b) comprises heating the jet stream through ohmic
2 power dissipation.

1 43. The process of claim 23 wherein step (b) comprises heating the jet stream to a temperature
2 substantially above a melting temperature of the conductive fluid.

1 44. The process of claim 23 wherein step (c) comprises controlling a depth of penetration of the
2 jet stream on the workpiece.

1 45. The process of claim 23 wherein step (c) comprises adjusting a velocity of the jet stream.

1 46. The process of claim 25 wherein step (a3) comprises controlling a pressure in the jetting

- 2 head.
- 1 47. The process of claim 25 wherein step (a2) further comprises controlling a temperature of the
2 conductive fluid.
- 1 48. The process of claim 23 further comprising moving the workpiece relative to the jet stream.
- 1 49. The process of claim 23 further comprising providing a current collector comprising a
2 conductive material disposed underneath the workpiece, the current collector forming an
3 electrical contact with the jet stream.
- 1 50. The process of claim 25 wherein the feed stock and the workpiece comprise a same material.
- 1 51. The process of claim 25 wherein the feed stock and the workpiece comprise different
2 materials.
- 1 52. A crucible for a metallic liquid jet cutting system, wherein the crucible comprises side walls
2 and a base, the crucible being formed of a zirconium containing compound that is electrically
3 conductive and is resistant to dissolving in the presence of a metallic melt.
- 1 53. The crucible of claim 52 wherein the metallic melt comprises one of iron, iron containing
2 compound, and aluminum.
- 1 54. The crucible of claim 52 wherein the crucible comprises one of zirconia diboride and yttria-
2 stabilized-zirconia.
- 1 55. A nozzle for a metallic liquid jet cutting system, wherein the nozzle comprises a disk-
2 structure having an orifice, wherein the orifice is located at a center of the disk-structure, the
3 nozzle being formed of a zirconium containing compound that is electrically conductive and
4 is resistant to dissolving in the presence of a metallic melt.
- 1 56. The nozzle of claim 55 wherein the metallic melt comprises one of iron, an iron containing
2 compound, and aluminum.

- 1 57. The nozzle of claim 55 wherein the nozzle comprises zirconium diboride.
- 1 58. The process of claim 25 wherein the feedstock is one of tin, aluminum, iron, and mild steel.
- 1 59. The system of claim 8 wherein the jetting head comprises at least two inlets for receiving
2 multiple feedstocks of the conductive material.
- 1 60. The system of claim 59 wherein a third power source is connected to at least one feedstock.
- 1 61. The system of claim 6 wherein the heater is an induction heater having a characteristic
2 frequency that can be calibrated to the level of the conductive fluid.
- 1 62. The process of claim 23 wherein step a) further comprises filtering the conductive fluid.
- 1 63. The system of claim 3 wherein the crucible further comprises a conductive fluid filter.